THE INFLUENCE OF EGYPT UPON TEMPLE-ORIENTATION IN GREECE.

I HAVE shown in former articles that in our own days and in our own land the idea of orientation which I have endeavoured to work out to the best of my ability for Egypt still holds its own. It is more than probable, therefore, that we shall find the intermediate stages in those lands whither by universal consent Egyptian ideas percolated.

Among these lands Greece holds the first place. It is perhaps proper that I should state here that the view as to the possibility of temple orientation being dominated by astronomical ideas first struck me at Athens and Eleusis, and that I endeavoured to settle the question by studying the Egyptian monuments, because they were the only monuments I could study as a stay-at-home, thanks to the labours of the French Commission and of Lepsius.

When I found that the same idea had been held by Nissen, and that the validity of it seemed to be beyond all question, I consulted my friend, Mr. F. C. Penrose, particularly with regard to Greece, as I knew he had made a special study of some of the temples, and that, being an astronomer as well as an archæologist (for, alas, they are not as I think they should be, convertible terms) it was possible that his observations with regard to them included the requisite data.

I was fortunate enough to find that he had already determined the orientation of the Parthenon with sufficient accuracy to enable him to agree in my conclusion that that temple had been directed to the rising of the Pleiades. He has subsequently taken up the whole subject with regard to Greece in a most admirable and complete way,[1] and has communicated papers to the Society of Antiquaries, February 18, 1892, and more recently to the Royal Society, April 27, 1893, on his results.[2]

The problem in Greece was slightly different to that in Egypt; we had not such a great antiquity almost without records to deal with, and moreover the feast calendars of the various temples presented less difficulty.

There was no vague year to contend with, and in some cases the actual dates of building were known within a very few years. Mr. Penrose has been convinced that in Greece, as in Egypt, the stars were used for heralding sunrise. He writes:—

"The object the ancients had in using the stars was to employ their rising and setting as a clock to give warning of the sunrise, so that on the special feast days the priests should have timely notice for preparing the sacrifice or ceremonial, whatever it may have been:

"Spectans orientia solis
Lumina *rite* cavis undam de flumine palmis
Sustulit," &c.

In Greece, not dominated by the rise of the Nile, we should not expect the year to begin at a solstice but rather at the vernal equinox. I have shown that even in pyramid times in Egypt the risings of the Pleiades and Antares were watched to herald the equinoctial sun; it is not surprising, therefore, to find the earliest temples in Greece to be so oriented. Mr. Penrose has found the following:—

η Tauri (The Pleiades)	Archaic temple of Minerva	Athens[3]	R	1530
	Asclepieion	Epidaurus	R	1275
	The Hecatompedon site of Parthenon	Athens	R	1150
	Temple of Bacchus	Athens	R	1030
	Temple of Minerva	Sunium	S	845

				B.C.
Antares	Heræum	Argos	R	1760
	Earlier Erechtheum	Athens	S	1070
	Temple at	Corinth	S	770
	Temple on the mountain .. .. Jupiter Panhellenius	Ægina	S	630

Here we find the oldest temple in a spot which by common consent is the very cradle of Greek civilisation.

It has also been shown that in Khu-en-Aten's time the new sun-temple at Tell el-Amarna was oriented to Spica, Spica too, we find, so used in Greece in the following temples.

				B C.	
Spica	The Heræum at	Olympia	R	1445	
	Nike Apteros	Athens	S	1130	
	Themis ...	Rhamnus	R	1092	
	Nemesis ...	Rhamnus	R	747	
	Apollo	Bassæ	R	728	Eastern doorway
	Diana	Ephesus	R	715	

When owing to precession the sun's spring equinox place had receded from Taurus and entered Aries, in Egypt the equinoxes were no longer in question, since the solstitial year was thoroughly established, and consequently we find no temples to the new warning star α Arietis.

In Greece, however, where the vernal equinox had now been established as the beginning of the year, we find a different state of things, no less than 7 temples oriented to α Arietis are already known.

α Arietis	Minerva	Tegea ...	R	1580	
	Jupiter Olympius	Athens ...	R	1202	
	Jupiter	Olympia ...	R	790	
	Temple (perhaps Juno)	Platea ...	S	650	
	Jupiter	Megalopolis	S	605	
	Temple at the harbour ...	Ægina ...	S	580	
	Temple on Acropolis of Mycenæ	...	R	540	Eastern doorway
	The Metroum ...	Olympia ...	S	360	

The above are all intra-solstitial temples, that is, the sunlight as well as the light of the star can enter them, and this enables us to note a certain change of thought brought about in all probability by the artistic spirit of the Greeks. The Egyptian temples were all dark, often with the statue of a god or a reptile obscure in the naos, and many were oriented so that sunlight never entered them. Mr. Penrose points out that almost all the Greek temples are oriented so that sunlight can enter them, of such temples we have the following 27.

7 examples from Athens.
3 ,, Olympia.
2 ,, Epidaurus.
2 ,, Rhamnus.
2 ,, Ægina.
2 ,, Tegea.
1 ,, Nemea.
1 ,, Corcyra.

1 example from Sunium.
1 ,, Corinth.
1 ,, Bassæ.
1 ,, Ephesus.
1 ,, Platæa.
1 ,, Lycosura.
1 ,, Megalopolis
2 ,, Argos.

Now in all these Greek temples, instead of the dark naos of the Egyptian building, we find the cella fully illumined and facing the entrance. Frequently, too, there was a chryselephantine statue to be rendered glorious by the coloured morning sunlight falling upon it, or if any temple had the westerly aspect by the sunset glow.

It was perhaps this, combined with the later invention of water clocks for telling the hours of the night, which led to the non-building of temples resembling those at Thebes and Denderah facing nearly north. Still there are scattered examples; one of very remarkable importance, as it is a temple oriented to γ Draconis 1130 B C., built therefore not very long after the temple M at Karnak, and this temple is at Bœotian Thebes! A better proof of the influence exerted by the Egyptians over the temple building in Greece could scarcely be imagined. As Mr. Penrose remarks:—

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[1] In the lists of temples which follow all the orientations were obtained from azimuths taken with a theodolite, either from the Sun or from the planet Venus. In almost every case two or more sights were observed, and occasionally also the performance of the instrument was tested by stars at night. The heights subtended by the visible horizon opposite to the axes of the temples were also observed.

[2] See NATURE, February 25, 1892, and May 4, 1893.

[3] R indicates a rising, and S a setting observation.

"Thebes was called the City of the Dragon, and tradition records that Cadmus introduced both Phœnician and Egyptian worship."

It would be very surprising if we assume, as we are bound to do, that these temples to stars were built under Egyptian influence, that Sirius should not be represented among them, that being the paramount star in Egypt at a time when we should expect to find her influence most important in Greece. Still, I have shown already that as the Greek year ignored the solstice, the use of Sirius as a warning star for all purposes of utility would not come in. Mr. Penrose finds, however, that in spite of this Sirius was used for temple worship.

"Leaving the solar temples, we find that the star which was observed at the great Temple of Ceres must have been Sirius, not used, however, heliacally—although this temple is not extra solstitial—but for its own refulgence at midnight. The date so determined is quite consistent with the probable time of the foundation of the Eleusinian Mysteries and the time of year when at its rising it would have crossed the axis at midnight agrees exactly with that of the celebration of the Great Mysteries.

"It is reasonable to suppose that when, as in the case of Sirius at Eleusis, brilliant stars were observed at night, the effect was enhanced by the priests by means of polished surfaces."

Another question. Does the star follow the cult in Greece as it does in Egypt?

In Greece we find the following:—

"The star α Arietis is the brightest star of the *first sign of the Zodiac*, and would therefore be peculiarly appropriate to a temple of Jupiter. The heliacal rising of this star agrees both with the Olympieium at Athens and that at Olympia. There is a considerable difference in the deviation of the axes of these two temples from the true east; but this is exactly accounted for by the greater apparent altitude of Hymettus over the more distant mountain at Olympia.[1]

"The Pleiades are common to the following temples of Minerva, viz. the Archaic temple on the Acropolis, the Hecatompedon, and Sunium. In the two former it is the rising, the latter the setting star.

"There must have been something in common between the temples at Corinth, Ægina, and Nemea. The two last, at any rate, are reputed temples of Jupiter."

The Greek side of the inquiry becomes more interesting when the connection between the orientation of the intra-solstitial temples and the local festivals are inquired into; in Egypt this is all but impossible at present.

A temple oriented to either solstice can only be associated with the longest or with the shortest day; if the temple points to the sunrise or sunset at any other period of the year the sunlight will enter the temple twice whether it points to the sunrise or sunset place.

Now Mr. Penrose finds that in Greece as in Egypt the initial orientation of each intra-solstitial temple was to a star, and this would, of course, secure observations of the star and the holding of an associated festival at the same time of the year for a long time. But when the precessional movement carried the star away they would only have the sun to depend on, and this they might use twice a year. It is possible, as Mr. Penrose remarks, there would have been no reason for preferring one of these solar coincidences to the other, and the feast could have been shifted to a different date if it had been thought more convenient." He goes on to add, "It would appear that something of this sort may have taken place at Athens, for we find on the Acropolis the Archaic temple, which seems to have been intended originally for a vernal festival, offering its axis to the autumnal sunrise on the very day of the great Panathenaia in August.

"The Chryselephantine statue of the Parthenon, which temple followed on the same lines as the earlier Hecatompedon (originally founded to follow the rising of the Pleiades after that constellation had deserted the Archaic temple alongside), was lighted up by the sunrise on the feast to the same goddess in August, the Synæcia, instead of some spring festival, for which both these temples seem at first to have been founded.

"The temple at Sunium, already quoted for its October star-heralded festival to Minerva, was oriented also axially to the sun on February 21, the feast of the lesser mysteries."

I have had to insist again and again that in the case of the Egyptian temples the stated date of foundation of a temple is almost always long after that in which its lines were laid down in accordance with the ritual. No wonder then that the same thing is noticed in Greece.

"In about two-thirds of the cases which I have investigated the dates deduced from the orientations are clearly earlier than the architectural remains now visible above the ground. This is explained by the temples having been rebuilt upon old foundations, as may be seen in several cases which have been excavated, of which the archaic Temple of Minerva on the Acropolis of Athens and the Temple of Jupiter Olympius on a lower site are instances. There are temples also of the middle epoch, such as the examples at Corinth, Ægina, and the later temples at Argos and at Olympia (the Metroum at the last named), of which the orientation dates are not inconsistent with what may be gathered from other sources."

The problem is, moreover, helped in Greece by architectural considerations, which are frequently lacking in Egypt, of two temples it can be shown, on this evidence alone, that one is older than the other. Such an appeal strengthens my suggestion that two of the temples of the Acropolis Hill were oriented to the Pleiades, by showing the older temple to point to an earlier position of the star group. To these Mr. Penrose adds another pair at Rhamnus, where he has found that there are two temples almost touching one another, both following (and with accordant dates) the shifting places of Spica, and still another at Tegea.

J. Norman Lockyer.

[In a letter received from Mr. Penrose, giving me permission to use the above quotations from his preliminary account, he makes the following interesting statements:—

"In my paper sent to the Royal Society there was a passage which seems to make it practically *certain* that heliacal stars were connected with the intrasolstitial temples as derived from Greek examples alone, independent of the powerful aid of the Egyptian cases.

"That the first beam of sunrise should fall upon the statue centrally placed in the adytum of a temple or on the incense altar in front of it on a particular day, it would be requisite that the orientation of the temple should coincide with the amplitude of the sun as it rose above the visible horizon, be it mountain or plain.

"That a star should act as time-warner it was necessary that it should have so nearly the same amplitude as the sun that it could be seen from the adytum through the eastern door, if it was to give warning at its rising, or to have a similar but reversed amplitude towards the west, if its heliacal setting was to be observed; and it follows that in the choice of the festival day and the corresponding orientation, on these principles, both the amplitude of the sun at its rising and that of the star eastwards or westwards as the case might be would have to be considered in connection with one another.

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[1] With regard to a temple of Minerva using α Arietis at Tegea, Mr. Penrose writes:—"Minerva is allowed by the poets to have been able to use Jupiter's thunder, so this is no misappropriation of the star. Juno also seems to have claimed the use of α Arietis as at Samos, and at Girgenti it suits the orientation of the temple of Juno better than Spica. But Spica seems to have been connected with the worship of Juno and Diana in their more strictly female capacity."

"From what has been said it is obvious that in the intrasolstitial temples the list of available bright stars and constellations is in the first instance limited to those which lie within a few degrees of the ecliptic, and it will be found that in the list above given and those which follow, if we omit Eleusis, where the conditions were exceptional, all but one of the stars are found in the zodiacal constellations. A very great limit is imposed in the second place by one of the conditions being the heliacal rising or setting of those stars from which the selection has to be made. So that when both these combined limitations are taken into account it becomes improbable to the greatest degree that in every instance of intrasolstitial temples of early foundation of which I have accurate particulars, being twenty-eight in number and varying in their orientation from 21° N. to 18° 25′ S. of the true east. There should be found a bright heliacal star or constellation in the right position at dates not in themselves improbable unless the temples had been so oriented as to secure this combination.

"I have just been looking into the number of possible stars which could have been used, *i.e.* within the limits of the greatest distance from the ecliptic that could have been utilised.

"The stars which could have been utilised in addition to the seven which serve for nearly thirty temples are ten only, viz. :—

Aldebaran.
Pollux.
β Arietis.
β Tauri.
α and β Capricorni as a group.
β Libræ.
α Libræ.
α Leonis.
γ Leonis.
β Leonis.

"If the orientations had been placed at random would not our thirty temples have made many misses in aiming at these seventeen stars, it being necessary also to hit exactly the heliacal margin? And would they have secured anything like a due archæological sequence?

"Another point is this:—

"Whenever a star less than first magnitude is used (Pleiades only excepted) it has been necessary to secure coincidence to give it several more degrees of sun depression than in the cases of Spica and Antares."]

BRITISH ASSOCIATION MEETING.

FURTHER information is now to hand as to the scientific work which has been arranged for the approaching meeting of the Association at Nottingham.

In Section A two papers have been received on "Physics Teaching in Schools." G. H. Bryan contributes an interesting paper on "The Moon's Atmosphere and the Kinetic Theory of Gases," showing that every planet must be throwing off some of its atmosphere on the kinetic theory, though at an exceedingly slow rate in the case of the larger bodies. Prof. J. J. Thomson will exhibit and explain a new form of air-pump, which will be of interest to sections A and B. Prof. Viriamu Jones is sending a paper on "Standards of Low Electrical Resistance."

As reported by Prof. Emerson Reynolds on p. 416, Section B has been most fortunate in securing a promise from M. Moissan to describe and demonstrate the preparation and properties of fluorine. This will probably have the effect of inducing chemists from all parts of this country to visit Nottingham, as the demonstration has never yet been made in this country, and is of almost unique importance and interest. It is anticipated that M. Moissan's communication will be put down for Monday, September 18, and will probably include the exhibition of his artificial diamonds. Prof. Percy Frankland will introduce the discussion on "Bacteriology in its Chemical Aspects" on Friday, 15, and amongst other papers will be one by J. T. Wood, on "A New Bran Bacterium." Tuesday, 19, will probably be mainly devoted to the discussion of "Colliery Explosions," introduced by Prof. H. B. Dixon, one of H.M. Commissioners. On this day further communications on flame researches are also expected. The President's address is put down for twelve o'clock on Thursday, September 14; it will deal essentially with "The Comparative Chemistry of the Elements," specially treating of carbon and silicon, and of silico-organic researches; showing further that it is possible in the light of recent knowledge to fill in some details of the chemical history of the earth. Dr. Phookan has promised a description of his recent researches on the "Rate of Evaporation of Bodies in Different Atmospheres."

In Section C Prof. Hull will read a paper "On the Water-supply of Nottingham"; Mr. Walcot Gibson, one on "The Geology of British East Africa"; Prof. Brögger will describe "The Eruptive Rocks of the Christiania District"; E. T. Newton, "The Trias Reptiles"; Prof. Sollas, "The Carlingford Rocks" and "Glendalough Amphibolite"; R. M. Deeley, "The Drifts of the Trent Valley"; and Prof. Iddings, of Chicago, "The Petrology of a Dissected Volcano." Amongst other papers already promised are the following:—"The Gypsum Deposits of Nottinghamshire," by A. T. Metcalfe"; "Derbyshire Toadstone," by H. A. Bemrose; "Mollusca from the English Trias," by R. B. Newton; "Transported Mass of Chalk in Boulder-clay of Culworth, in Huntingdonshire," by A. and C. Cameron; "Some Volcanic Rocks of South Pembrokeshire," by F. T. Howard and E. W. Small; "Midland Trias," by Dr. A. Irving; "Limestone Inclusions in the White Sill," by E. T. Garwood.

Two further papers are sent in for Section D—one by Prof. Gilson, of Louvain, on "Cytological Difference in Homologous Organs," and one by G. B. Rothera, on "Some Vegetal Galls and their Inhabitants."

In connection with Section E the exhibition of the 120 pictures painted on an Antarctic sealing expedition by Mr. Burn-Murdoch has been referred to. The discussion on the "Limits between Geography and Geology" will be introduced by Mr. Clements R. Markham, Pres.R.G.S. Mr. Delmar Morgan will summarise our knowledge of Thibet, and Miss Taylor will describe her recent journey in that country. Mrs. Grove will read a paper on the "Islands of Chiloë." Mr. E. G. Ravenstein will give an account of recent African travel; and a large number of other papers are promised, many of which are of more than ordinary interest. The illustration of many of these papers by lantern photographs will be a special feature.

With respect to Sections F and G there is at present nothing further to add to the original statement made a few weeks since.

In Section H Mrs. Grove promises a paper, "The Ethnographic Aspects of Dancing." Prof. Boyd Dawkins, who is now on a visit to Glastonbury, intimates his intention to discuss the scientific bearings of the discoveries made at the lake village in that neighbourhood; and, in order that the members may be better able to understand the structural details of the woodwork exposed in the course of the excavations, Dr. Munro proposes to give an illustrative sketch of the different methods adopted in the construction of lake-dwellings. Hitherto lake-dwelling researches have furnished little evidence of the kind of houses erected on the artificial islands, but during last autumn a crannog was investigated in Argyllshire which has disclosed some remarkable information on this point. The discussion on lake-dwellings is fixed for Sept. 19, and as this important subject has formerly only incidentally come before the Association, the occasion promises to be most instructive to all interested in the early history of Britain. Among the other papers sent to